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ABSTRACT

This paper examines various issues related to the teaching of science to hearing impaired students at the elementary school, intermediate school, secondary school, and college levels. Also included are: (1) summaries of national surveys on the state-of-the-art; (2) suggested strategies for teaching hearing impaired students; (3) three case studies of typical hearing impaired students; (4) a discussion of safety considerations for the laboratory; (5) information on career education; and (6) a discussion of computer applications in teaching hearing impaired students. (JN)

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The Hearing-Impaired Student

In

The Science Classroom

Harry G. Lang, Ed.D.

SE 045 797

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Teaching Hearing-Impaired Students Science

Without doubt, the advent of Public Law 94-142, the Education of All Handicapped Children's Act in 1975, was a turning point in the history of teaching science to hearing-impaired students. "Turning point," however, may not be the best choice of words. It was more a starting point in sharing information with others in the mainstream, especially for special educators responsible for teaching science. Through working conferences, published articles, and active involvement of professional organizations such as the Association for the Education of Teachers in Science (AETS), National Science Teachers Association (NSTA), and the American Association for the Advancement of Science (AAAS), instruction and curriculum development for special education have been improved in schools and programs serving hearing-impaired science students. Thousands of science teachers have joined together to promote handicapped youngsters' learning of science through these organizations and associated groups such as Science for the Handicapped Association and the Foundation for Science and the Handicapped.

We are now at a stage where materials and methods are commercially available, but their existence has yet to be adequately communicated to training programs. Continued efforts to improve both the materials and the means for disseminating them should be a priority for the next decade. Above all, in-service and preservice training programs need to recognize two important targets. Science teachers in the mainstream need to have additional training and sensitization to the educational implications of handicaps. Those who teach in the special education programs need to realize the importance of science as an integral component of the whole school curriculum for all students. Both of these needs can be met only through improved communication among those responsible for teacher training.

Throughout history, the hearing-impaired student has been a victim of controversy regarding methods of teaching and communicating. Despite the political, financial, and, especially, attitudinal problems inherent in Public Law 94-142 and its implementation, several appropriate concepts have emerged. The basic concept behind individualized educational planning is that each student has unique learning needs, and one must take care not to apply stereotypes to these individuals. A second important concept is that of the least restrictive environment. An environment which facilitates healthy learning and development for one student may not be effective for another. Teachers must seek to understand the handicapped student as an individual. The focus should be on the child's abilities, not on the disability.

Elementary-Level Science

As with normal-hearing children, the hearing-impaired child learns to assimilate knowledge as both the mind and the environment make their contributions to an understanding of the world. Piaget often stressed that one cannot effectively teach concepts verbally to children. A method founded on activity and experience must be used. In American education, there has been historical support for John Dewey's dictum of learning by doing and the need for environmental and experiential stimuli. Piaget and Dewey are brothers in this regard, and their brotherhood should be shared by more science and mathematics teachers. When educating young hearing-impaired students, in particular, "learning by doing" should be a maxim. The hearing-impaired student is as curious as the hearing student and should have experiences which permit the acquisition of knowledge, testing of hypotheses and gradual development of reasoning. Owsley (1962) emphasizes that science, more than any other subject in the curriculum, should teach a scientific approach to problem-solving.

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This involves asking questions, making careful observations, and being tolerant of new ideas. The scientific method also helps one to learn to recognize problems, identify evidence, predict possible outcomes, determine potential solutions, and transfer learning to other situations. The elementary school, says Owsley, where students retain flexible minds, is the ideal place to begin. He writes:

> Science can be interesting to teach when you see deaf children wondering, questioning, exploring, discovering and reacting to the exciting world of science. When progress is steady because you are backed up by a well-organized, teachable program, a program you feel at home with. (sic) When you know you're building for the future - establishing a strong foundation for children's later studies in science - preparing deaf children to do good thinking... p. 340.

The last point Owsley makes is crucial. Even more important than acquiring a substantial body of scientific information, we, as teachers, must equip hearing-impaired students with a method of work and a habit of critical thinking. We should continue to encourage them in every way possible so that they will not lose interest.

A child's social growth also greatly affects the ability to communicate with others, and, therefore, to learn. This dimension is extremely significant for hearing-impaired students. Hearing-impaired students often lack some of the basic abilities to initiate and maintain social interactions. This may be because many schools place a premium on immobility, even though the student's attention span and interest are increased greatly during motor activities. Leitman (1968), in one of the earliest papers on teaching science to hearing-impaired students, wrote that the many hours spent by these students in groups tend to foster passivity, which runs counter to the need to explore the environment. There appears to be a general consensus among teachers that

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hearing-impaired students are more successful in science programs that involve self-initiated discovery and exploratory "hands-on" experiences.

Many curriculum programs used with normal-hearing students may prove just as effective with hearing-impaired students. Unfortunately, they have not been adequately tested with students having impaired hearing. Science-A Process Approach (S-APA II), for example, is built around an activity-oriented curriculum aimed at developing various processes of science. The program utilizes instructional kits, booklets for teachers with objectives, evaluation instruments, and suggested teaching strategies. The carryover of interest and extension of concept development into other academic areas seems to make S-APA a highly recommended program for hearing-impaired students.

Dietz and Ridley (1975) describe the application of the Science Curriculum Improvement Study (SCIS) to the education of young hearing-impaired students. Developed at the University of California at Berkeley, SCIS is a sequence of physical and life science modular units using the laboratory investigation approach for grades K-6. Involvement with SCIS materials encouraged the hearing-impaired students to express their ideas about activities while developing an understanding of the science concepts.

There are other curricular projects that similarly focus on a discovery approach which may well prove more successful with hearing-impaired students than traditional textbook methods. The Conceptually Oriented Program in Elementary Science (COPES) is a non-reading project for students with serious verbal problems in grades K-6. Developed at New York University, the instructional units include materials which assist in evaluating the student's understanding of major conceptual schemes. The Unified Science and Mathematics for Elementary Schools (USMES) program is an interdisciplinary study of problems

from the school and community environment (K-8). The Learning Research and Development Center of the University of Pittsburgh has a comprehensive K-6 curriculum with a learning management system available for those interested in individualization. These programs should be evaluated for their effectiveness with hearing-impaired students.

Intermediate-Level Science

When students are between ten and fourteen years of age, they mature cognitively as well as physiologically and emotionally. Social development adds a new interpersonal dimension. The young adolescent experiences changes which provide new ways of looking at and valuing the world. They become capable of building theories and philosophies and gain insight into the intellectual process by which scientific knowledge develops. Both hearing and hearing-impaired adolescents begin to think more about self-identify and their role in society. The importance of career planning becomes increasingly apparent. But regardless of the students' expressed interest or indicated abilities, science instruction can be beneficial. Everyone needs to attain a degree of scientific literacy fundamental to living in a technically-oriented society. This includes, for example, the most basic necessities such as understanding electric and gas bills, environmental controversies, the doctor's diagnosis of an ailment, or news articles about space exploration and technical innovations.

Science activities for hearing-impaired students on the junior high level should emphasize discovery of principles and experimental solutions to problems. Constantly verifying anticipated results does not assist the student in thinking critically and discovering relationships. It does not confirm that students understand how they got certain results, nor that they are able to

apply them to other problems. Anselmini (1967), in describing a junior high school science curriculum for hearing-impaired students in New York City, emphasized the factors of individual laboratory lessons, hands-on experiences, utilization of media, and planning a careful sequence of science topics. The topics should provide not only an understanding of facts and skills, but should give the hearing-impaired student a background for future course work. Anselmini also stressed the importance of correlating science instruction with the development of language, reading, speech, and speechreading skills.

Concern about reading skills is not unique to teachers of hearing-impaired students, however. In one NSTA survey of 360 middle/junior high school science personnel from 39 states and the District of Columbia, a chief concern of junior high school teachers was reading in science classes (Hofman, 1977). Science teachers ranked poor reading skills as the most prevalent problem. There are millions of students with limited proficiency in English in American classrooms.

On the junior high level, hands-on experience has been advocated as a method preferred to simply reading about science. Some research has supported this preference. Boyd and George (1973), for example, described a study designed to determine if experiences in manipulating physical objects could increase classification abilities of hearing-impaired students ten to thirteen years old. The study revealed increased scores for the hearing-impaired students in the experimental group.

Although there is a lack of research literature on methods for teaching science to hearing-impaired students above the elementary grades, it is apparent that open-ended experiments which arouse interest in additional discovery can capitalize on the hearing-impaired student's developing mental abilities.

Many hearing-impaired students have a short attention span. The strain from the constant effort to communicate through visual modes can be tiring, particularly in a lecture class. Hands-on experiences offer more variety and visual "breaks" which can motivate students and provide the physical access to opportunities to learn. Contemporary curricula such as the Intermediate Science Curriculum Study (ISCS) and the Inquiry Development Project (IDP) may prove more effective with hearing-impaired students than traditional, didactic methods of teaching general science.

Secondary-Level Science

Many of the science curriculum projects that have been developed for hearing high school pupils have not been extensively used with the hearing-impaired student, in spite of their emphasis on hands-on activities and use of visual media. There have been recent efforts toward individualizing these activities. Perhaps the lack of use of these Federally-funded projects in school programs serving hearing-impaired students is because the materials were originally developed with the science-oriented student in mind. The reading levels of these materials are quite challenging.

College-Level Science

Even on the college level, educators frequently advocate the use of exploratory, hands-on experimental work as important to the reinforcement of a concept or theory when teaching hearing-impaired students. Science teachers should note the hearing-impaired student's primary use of the eye in collecting information, whether it is used to interpret oral or manual language, visual aids, or experimental findings. Bybee (1972) discussed the use of physical exploration as a "powerful motivator" toward learning science and, more importantly, language. Lang (1973) described the success encountered in

a curriculum which emphasized hands-on experience and self-pacing strategies in college physics.

National Surveys: State of the Art

In the late 1970s and early 1980s, steps were taken to survey present practices and needs of science teachers working with hearing-impaired students. Burch and Sunal (1978) surveyed elementary science teachers in forty-seven residential schools and reported that 21% had no established science programs for grades K-6. Fewer than 20% of the schools surveyed used guidelines for special help, or strategies and activities different from approaches used in regular school curricula. The authors concluded that if this sample is typical of all schools in the population, science teachers in a majority of schools are not providing appropriate science instruction for young hearing-impaired students.

A major survey in the early eighties (Lang and Propp, 1982) had the following goals: 1) to examine the education and training of those teachers responsible for science classes; 2) to provide a description of the general adequacy of science curricula, instructional resources, and facilities; and 3) to identify major needs in science education for hearing-impaired students.

480 science teachers representing 326 school programs in 45 states and the District of Columbia responded with 34.7% of the respondents teaching science to hearing-impaired students in residential schools and 65.3% teaching in mainstream programs (both public day schools and public day classes). More than two-thirds of the teachers responding to the survey were female.

The survey revealed that few science teachers working with hearing-impaired students have had adequate preservice or inservice training in

science education (methods courses). 73.6% of the respondents had no degrees in science education with almost half of these teachers stating that they did not even take one college science course. Many obtained their college education in disciplines other than science education. This includes degrees in such disciplines as music, finance, home economics, art history, mathematics, administration, and physical education. A large number of respondents have degrees in general and special education, particularly in speech pathology and audiology. In this survey, the science teachers of hearing-impaired students identified their greatest needs in the areas of teacher training and materials development to meet the language needs of hearing-impaired students.

Instructional Strategies

Those of you who have never played tennis can only wonder how silly and awkward you would look on the court for the first few times. Having never picked up a racquet, served the ball into the deuce court or kept score in a game, set, or match, you would likely experience frustration and despair! Things could even be worse. Perhaps you have never heard others discuss the general tennis rules, behaviors or ethics. Your opponent may think of you as rude or unsportsmanlike at the end of your first match when you neglect, unintentionally, to shake hands across the net. Even though you have the aptitude and ability to learn tennis skills and strategies in time, bystanders are likely to provide you with an unfair label based on their observations at that time.

Few people like such an embarassing situation. Yet as educators we often fail to consider the serious effects this kind of experiential restriction has on a student's understanding in class. A young child playing on the living

room floor may hear a doorbell and begin hypothesizing on a primitive level. "Perhaps it's Grandma!" "Maybe Joey has come to visit?" The same child hears siblings arguing over the rules to a game or parents discussing a project for remodeling the kitchen. These are oportunities to observe, communicate, predict, and make inferences. Science process skills are thinking skills which develop through the early years, including the pre-school years. The hearing-impaired child, however, misses out on many of these primary and vicarious experiences which provide opportunities for cognitive, linguistic, and social development. The lag behind hearing students begins early and may continue to grow if effective communication and teaching are not introduced quickly. Educators have traditionally focused on language development as an isolated major need. Several national surveys of science teachers have shown that many schools have placed little emphasis on science in the curriculum for hearing-impaired students (Lang and Propp, 1982; Sunal and Burch, 1982). This is a grievous mistake. Science can be a vehicle for learning speech, reading, and writing skills. Hundreds of articles have been published, offering teaching strategies for hearing students which establish science as a context for the development of language, thinking, and social skills. The strategies are not that much different for hearing-impaired students. More emphasis is needed, however.

Various authors have also provided specific suggestion for science teachers who are teaching hearing-impaired students. Interested readers may refer to the publications listed in the back of this monograph for additional reading. Here are a few of the more salient suggestions offered by the professionals:

Pedagogical Suggestions	References
1. Ask the student where she or he wishes to sit in the classroom. Individual preferences may depend on amount of residual hearing (and use of amplification), uninhibited view of interpreter or teacher, or sources of visual distractions (e.g., window behind teacher makes it difficult to lipread, because of drapes blowing in the wind, traffic outside the classroom door, etc.).	Cain (1981) Gavin et al (1981) Lang (in press) Keller et al (1983)
2. Hand out notes or have someone take notes for your hearing-impaired students. It is very difficult to attend to two or more visual tasks at once. The hearing-impaired student needs to focus on watching an interpreter or lipreading the teacher. Because of this, notetaking is difficult.	Gavin et al (1981) Lang & Caccamise (1980)
3. Be careful not to create stereotypes about deafness and deaf people. Students vary in their ability to hear things. Individual differences among hearing-impaired students' learning styles, language skills, and speech intelligibility are common.	Lang & Caccamise (1980) Rohland & Lang (1983)

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Pedagogical Suggestions

References

Some students have high frequency losses; others cannot hear sounds well at low frequencies. Students whose onset of deafness occurred later in life often have little lag in language and speech development.

4. There are many different sign language systems. American Sign Language (ASL or Ameslan) is the native language for many students, especially those who were born deaf, or whose parents are deaf, too. For many ASL students, English is a second language. ASL has a distinct syntax (especially word order) and idioms of its own. Many other hearing-impaired students use one of the Manually-Coded English (MCE) systems which are manual representations of English in English word order. Still other hearing-impaired students do not know sign language and rely largely on speechreading (lipreading) and use of residual hearing.

Lang & Caccamise (1980)

Rohland & Lang (1983)

Pedagogical Suggestions	References
5. The problems which hearing-impaired students have with the English language are not the result of using sign language. Lack of exposure to and experience with English especially during the early years, explains the difficulties. Hearing-impaired students need continuous visual exposure to language within the home, school, and community environments. This exposure should be within the context of meaningful learning experiences, including science and mathematics classes.	For a review of language learning and early intervention strategies with deaf children, see Moores (1978)
6. Establishing a receptive environment should be considered one of the highest priorities. Other students may at first be bothered by the presence of an interpreter, or by the unique situations the hearing-impaired student brings to the classroom. The teacher, too, may feel somewhat uncomfortable in the presence of an interpreter. Most often, these feelings abate with time and the realization that the interpreter is a trained professional who is there to help, not to evaluate, the instructional process.	Cain (1981) Gavin et al (1981)

Pedagogical Suggestions	References
7. When testing hearing-impaired students, keep in mind the difficulties many students have with the language of the test instructions and items.	Lang (1983)

Conclusion

The effects of deafness on learning need to be understood by the classroom teacher. A simple list of classroom management suggestions will not suffice. Make every effort to learn about deafness as an educational condition. The more comfortable a teacher is with a hearing-impaired student, the more effective instruction will be in the classroom.

Case Studies of Typical Hearing-Impaired Students

1) Mary Beth, a very conscientious student in a biology course taught by Mr. Genes, has her heart set on a career in medical laboratory technology. Born profoundly deaf, Mary Beth's language skills are far from adequate. When Mr. Genes reads a laboratory report or a response to an essay question by Mary Beth, he is able to see the correct information, although it takes a great deal of deciphering. Unfortunately, the lab grades make up an important part of the total course grade, and Mr. Genes feels it is his responsibility to reduce Mary Beth's grade based on her language problems.

Mary Beth complains to Mr. Genes that this is "double jeopardy." She is already being graded on her language skills in English class. Her grades on objective-type test questions consistently show a mastery of biology content. Why should she be penalized again for something over which she has little control? Mr. Genes responds that if Mary Beth had a job in a medical laboratory, she would be expected to communicate clearly and concisely to fellow employees and supervisors. Mr. Genes and Mary Beth agreed to meet with the school's educational specialist who is trained to work with handicapped students. Ms. Peterson listens to both viewpoints and suggests a possible strategy for Mr. Genes to help Mary Beth with her language development to the satisfaction of both teacher and student.

Mr. Genes agrees to grade only those language-related skills which he has identified with Mary Beth as crucial for her to work on. They work together with her English teacher in identifying "local" and "global" errors. The global errors are those which influence the intelligibility of her writing. Local errors include such mistakes as missing articles (a, an, the) or incorrect endings (ing, ed, ion). These are not as serious. Mary Beth's progress

is reviewed periodically, and the strategy appears to be effective in improving her writing while not diminishing her motivation in biology.

2) James and Larry appear to be having much difficulty in Mrs. Smith's ninth grade physical science class. It is difficult to determine how much they are getting out of the class. They often look confused when new concepts are being introduced and fall asleep in class too often. The interpreter will not help Mrs. Smith with the problem, claiming that he has a "code of ethics" to follow. James and Larry are in danger of failing the course, and it doesn't help any that they talk to each other with their hands so much during class!

Mrs. Smith sees the resource room teacher, Mrs. Adams, in the teacher's lounge during a lunch break and decides to approach her with these problems informally. Having had little training in "special education," Mrs. Smith is surprised at what now appears to be obvious explanations for some of these behaviors. Mrs. Adams explains that James and Larry are having problems understanding the lectures. Many times they converse in sign language during class and try to help each other. While not free of some social chatter, the conversations are primarily for clarification of what's happening in class. Many times, the interpreter is at least a sentence behind the teacher and when Mrs. Smith points to an overhead or blackboard during her lecture, her finger has moved by the time James and Larry receive the message. Trying to take their own notes, too, has proven to be so visually taxing that they sometimes "give up" and rest their eyes. The interpreter has admitted that he is not quite familiar with many of the "technical" signs used in the science class and that he fingerspells so many words that he wonders if this, too, is taking its toll on the hearing-impaired boys' energies needed for learning.

Mrs. Smith and Mrs. Adams decide to try a pre-teach/teach/post-teach strategy. Mrs. Adams receives Mrs. Smith's notes a day early and meets with James and Larry to discuss the meanings of the key vocabulary words. They agree on the appropriate signs for these words, and they check with the interpreter. While teaching, Mrs. Smith is more conscious of the lag between her spoken words and the interpreter's signing, and she occassionally looks to the boys for subtle acknowledgements that they are following her. A fellow student has agreed to take notes using a special notetaking pad[1], and to meet with Mrs. Adams for some special instructions on taking notes for hearing-impaired peers. Mrs. Smith has also realized through her discussions with Mrs. Adams that her lectures would be more interesting and understandable if she made more use of concrete materials and demonstrations. Her "chalk-and-talk" method has probably bored many of her students. Later in the day, the two boys meet with either Mrs. Smith or Mrs. Adams (or both) to discuss what they have learned. Problems with talking and sleeping in class have practically disappeared since trying the new approach. The boys feel their teacher now "cares about them." They are gradually phasing out the post-teach stage as they develop confidence. Many of the hearing students in the class have been commenting about the fun they are having as Mrs. Smith introduces more and more hands-on activities.

3) Bonnie is a high school senior, profoundly deaf, and extremely interested in chemistry. She has had a dream of some day being a research chemist, but now her dream has been shattered. Her aptitude test scores are good, but her

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[1]See Osguthorpe and Whitehead (1979) for suggestions for training notetakers to use a special notetaking pad which produces multiple copies of notes.

career counselor does not believe science is an appropriate choice for handicapped students. Bonnie's parent were told that science was "too hard" for a handicapped student. At home, Bonnie and her parents have argued about this. They feel that her counselor knows best.

Bonnie was fortunate a few weeks later to find some brochures published by the Office of Opportunities in Science in the American Association for the Advancement of Science. She showed her counselor the brochures describing the successes of many handicapped scientists in various technical and professional careers. After calling the AAAS, the counselor received a copy of a directory listing hundreds of hearing-impaired scientists willing to serve as role models or to provide assistance. She met with some local scientists and found that the real handicap was not deafness, but the attitudes of others like herself. The call to the AAAS was the turning point in Bonnie's career development. Whether she would make it as a chemist or not, she realized that she would have to develop a measure of self-advocacy and fortitude in dealing with others who do not fully understand the dangers of stereotyping.

Safety in the Laboratory

Unfortunately for many handicapped students, various myths have been created about safety in the laboratory environment. Although there is plenty of evidence which dispel these myths, many teachers continue to harbor fears about the risks of having a handicapped student in a laboratory. Menchel and Ritter (1984) have thoroughly reviewed the literature, finding that hearing impaired workers have an above average on-the-job safety record.

Hearing-impaired students, as a result of their auditory deprivation, are usually very alert visually and tactually. They will often notice vibrations and seek their sources while the accompanying sounds may not elicit similar

curiosity in their hearing peers. This is probably a safety mechanism which many hearing-impaired students develop through experience. The principal safety concern for most science teachers with hearing-impaired students is that of making alarms visible. These include fire alarms and any special audible alerts to detect the presence of dangerous gases, etc. Some schools have assistive devices centers which will work with the maintenance personnel in modifying alarms and alerts with visual signalers (flashing lamps or strobe lights).[2] Many teachers have found the "buddy system" to be effective. This method involves pairing a hearing-impaired student with a hearing classmate as lab partners. Safety rules are established with responsibilities assigned to both partners.

A hearing-impaired student's (and all student's) eyes should be protected with appropriate safety goggles any time an experiment involves chemicals, glassware, electric sparks, or rotating machinery. This precaution should be taken when the hearing-impaired student is near such an experiment, even if she or he is not directly involved. Special goggles are available from science equipment suppliers for laser experiments. Some teachers like to take extra precaution with cabinets which sterilize eyewear to avoid possible problems with pink eye or other infections. Standard eyewashes and body washes are also appropriate to have in a laboratory.

Hearing-impaired students should be quizzed to check that they clearly understand the emergency procedures to follow. They should know the locations of the fire extinguishers/blankets, fire alarm, eyewash, and other apparatus

[2]For more information, write to the Hearing Aid Shop, National Technical Institute for the Deaf, Box 9887, One Lomb Memorial Drive, Rochester, NY 14623-0887.

and first-aid supplies. Above all, teachers must be role models in practicing safety. Students who see teachers pull plugs out by their cords or forget to use protective eyewear themselves can hardly be expected to take laboratory safety seriously.

Career Education

Many who teach hearing-impaired students will agree that, in general, they are very inquisitive. As they search for relevance in their activities, they need teachers and parents to provide them with both structured and unstructured learning experiences in the school, community, and home environments. And more important, they need increased awareness of who they are, what they are doing, and why they are doing it.

Career Development is a life-long experience, a process of growth and maturation which involves an internalization of attitudes and appreciations, a clarification of values, and a growing awareness of one's own interests and abilities. The collective career-related experiences and information acquired in the school, home, and community environments, both structured and unstructured, comprise career education. Career education is recognized as the bottom line in career development.

Formal career education is a planned program of experiences which enhance career development. Career education can provide hearing-impaired students with a sound base for mature and responsible career decision making. Hearing-impaired students need to know what is available to them in the world of work. They need to know what barriers they will face as a result of their hearing loss, and they need to learn how to overcome these barriers. To develop such awareness and to provide meaningful opportunities for exploring options,

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career concepts should be woven into the content areas of the curriculum as much as possible. Such a weaving process is called infusion (Black, 1981). Infusion of career education permits the student to see the relevance of the content areas to his or her occupational goals. It sets the stage for hearing-impaired students to choose intelligently among career and life roles.

As Walter S. Smith, author of the National Science Teachers Association publication Career Education in the K-12 Science Classroom, writes: "Career education provides a framework for our efforts as teachers of science" (Smith, 1979). Our students continually ask us why they are learning certain topics. When they ask why we are teaching the concept of pressure, they need to learn from us that there are hearing-impaired medical laboratory technicians working with blood pressure in hospitals today. There are civil engineers working with water pressure and mechanical engineers working with oil pressure. Even in the home, "pressure" must be understood in a variety of ways. When we teach energy conservation, we need to explain that this is a work habit that will become as valued as punctuality or conscientiousness over the next decade. Each time we show the relevance of our lesson to job skills, or other aspects of employment, we are involved in career education.

Self awareness is an element of career education that is most crucial to career decision making for all students. Young hearing-impaired people need to clarify what they believe in. They need to choose among alternatives and support their choices. They need to focus on their abilities rather than on their disabilities and explore their interests and talents. These students especially need to develop self advocacy for successful employment in today's competitive job market and in a less supportive social and economic environment. This awareness should and can begin within the context of their

academic classes. Whenever possible, hearing-impaired role models should be involved in helping these young people to develop self awareness.

Where can our students acquire decision making skills in order to make appropriate career choices? Students need experiences with processing information. There is no better place to develop cognitive, affective, and psychomotor competencies which accelerate career development than the science classroom. It is in the science classroom where students learn to compare, classify, and summarize. They learn to interpret information obtained from observations. They develop their abilities to critique, hypothesize, imagine, value, make decisions and examine the consequences of these decisions. Fundamental skills in measuring and manipulating acquired in the science classroom are preparatory to both consumer and work experiences. The science and mathematics classrooms are ideal environments for weaving career education concepts into the academic subject matter (Egelston-Dodd, 1978). The career education elements give relevance to learning the content. The science and mathematics skills and processes enhance career development through exposure and experience. This is what infusion is all about. Most of this will make sense to the teacher who understands the special needs of hearing-impaired students. And these are, indeed, concerns of parents and teachers of hearing students as well.[3]

The National Sciences Teachers Association publishes Science and Children and The Science Teacher which provides a wealth of information for science

[3]For more information on how parents and educators can enhance the career development of hearing-impaired children, contact the National Project on Career Education (see Egelston-Dodd, 1982).

teachers, through articles dealing with careers in science and how to encourage students to think about their future while studying science. The American Association for the Advancement of Science implemented its Special Project on the Handicapped in Science in 1975. Numerous publications and projects have been completed. Science for Handicapped Students in Higher Education (Redden, Davis, and Brown, 1979) describes barriers faced by handicapped students pursuing a career in science. These include attitudinal, communicative, environmental, financial, academic, and informational barriers. Recommendations for overcoming these barriers are provided and are highly applicable to all levels of schooling and to other areas of the curriculum. The AAAS Resource Directory of Handicapped Scientists (Owens, Redden, and Brown, 1978) lists hundreds of scientists by geographical location, sex, scientific specialty, and handicapping condition. These scientists, many of them hearing-impaired, are willing to act as role models or provide consultation for projects of a scientific or academic nature. Is Science A Possible Career For You? (Stolte, 1981) is a science career development program especially designed for hearing-impaired students. Funded by a grant from the National Science Foundation, the project was designed for use with thirteen-to sixteen year olds and includes infusion activities, a captioned film strip about six hearing-impaired people in science and mathematics careers, teacher references, suggested student readings, and optional activities. The materials are available from the National Association of the Deaf.

The Career Planning and Placement Center at the University of California, Irvine has developed and tested a model program designed to attract physically handicapped high school and community college students to enter careers in

science. Although not focusing on hearing-impaired students, the color videotape and accompanying training manual will be helpful materials for a career education planning team.

Computer Applications in Teaching Hearing-Impaired Students

Hearing-impaired students, like all students today, find themselves in the midst of computers at home and in the school. While microcomputers offer some promise in alleviating educational problems, they are no more a panacea than the hearing aid or the overhead projector. Regardless of the tools used in the classroom, we must continually remind ourselves of the formidable challenge deafness presents. Yet with appropriate applications, classroom use of microcomputers may provide breakthroughs in the education of hearing-impaired students. Already there are numerous exciting applications in the areas of communication skills development, math drill and practice, real-time captioning, information networks, and CAI. The number of applications of microcomputers in teaching hearing-impaired students is limited only by the imagination (Stepp and Reiners, 1983).

DEAFNET (see Middleton, 1983) and Special Net (Gibbs and Nash, 1983) provide electronic messages, bulletin board access, and real-time linking capabilities to those interested in deafness and educating deaf students. These networks provide immediate sources of information on trends and issues of concerns related to deafness.

While many software programs commercially available can be used with hearing-impaired students, teachers need to evaluate the language level of the materials for appropriateness. Many publishers will grant permission to educators to modify the programs when necessary. Another important consideration

is the rate of text presentation. Ideally the hearing-impaired student should have control over the rate of the text being shown and be able to pace this speed to his/her own reading ability.

Teachers will find many good software advertised by the major science publishers. Additional programs which have been tested more carefully with hearing-impaired students may be found in the following literature:

1. American Annals of the Deaf. A journal published for educators of hearing-impaired students by the Convention of American Instructors of the Deaf (CAID), 814 Thayer Avenue, Silver Spring, Maryland 20910. CAID also publishes the Advocate which keeps educators current with events in their field.
2. SIG Science News. Within the CAID, a Special Interest Group of science teachers publishes a newsletter for teachers across the country. These teachers are testing software and evaluating the programs for use with hearing-impaired students. You can join SIG Science by sending $3.00 to the CAID.
3. Perspectives. A magazine offering many practical suggestions and helpful information on materials and methods for teaching hearing-impaired students. Perspectives is published by the Pre-College Programs, Gallaudet College, Washington, D.C. 20016. The Pre-College Programs include the Model Secondary School for the Deaf and the Kendall Demonstration Elementary School. KDES is an excellent source of information about the current state of computer use among educators of hearing impaired students.

Summary

Whether in a special education or mainstream environment, teaching hearing-impaired students requires an understanding of deafness as an educational condition. The effects of deafness on learning need to be understood. We all do not need to have training in special education to be effective teachers. But we do need to be "special" teachers. A special teacher is one who cares about each individual in the classroom and continually strives to capitalize on the student's strengths and provide remedial opportunities when necessary. Special efforts make special teachers.

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